AMERICAN

RAILROAD JOURNAL,

AND

MECHANICS' MAGAZINE.

No. 8. Vol. III. New Series. | OCTOBER 15, 1839. | Whole No. 344. Vol. IX.

Errata.—Article, 'Right of way for Railroads, etc.,' page 196, 27th line, for "men," read *mere.* Page 197, 11th line, for 'Premier,' read *Province.* Same page, 21st line, for 'chamelion of corporation,' read *chamelion corporation.*

ERIE CANAL ENLARGEMENT UNNECESSARY,

From the decrease of tonnage derived from the forrest.—Railroads destined to change transportation from and to the sea board.

MESSRS. EDITORS:—It is now near five years since your valuable Journal admitted articles endeavoring to show the folly of this splendid piece of extravagance. The controversey of the State engineers with Mr. E. F. Johnson, who early took ground against their plan, to secure the western trade and *cheap transportation*, was admitted in your Journal in 1835, and a free discussion solicited, whilst other papers refused to investigate the subject.

Writers in your Journal, and the Times, of this city, questioned the truth of the estimate of $12,400,000, then made for the enlargement—the feasibility of doing it, within any reasonable time, and not intercept navigation on it—or at an expense that would be submitted to by the people. The advocates for the canal arround Niagara falls, and the improvement of *natural waters* from Oswego by lake Oneida, and the north side of the Mohawk river to the Hudson, [to provoke competition] and who warned the public that the estimates were deceptive, were ridiculed. That the estimate of the last winter, $23,400,000, which does not include damages and loss of interest during the construction, and is only an approximation to the truth, we are led to conclude, when we find that the State engineers, in 1835, estimated the cost of the Rochester Aqueduct of stone, at $141,074—when the actual cost will exceed $600,000. A wooden trunk to cost $30,000, would have been as durable as those they propose to build over the Mohawk. It is these estimates and useless expenditures, attended with the fact that the tonnage derived from the forrest, decreases faster than it is supplied by agriculture and manufactures, that has settled the question as to the propriety and necessity of the enlargement, to the injury of the State credit, and to the

prostration of other necessary works. Half the expenditure required for the Erie canal, to enlarge it, [with the destruction of the original work, which should be estimated in the cost of the *new canal,*] will complete every important line of railway in the State of New York.

If $30,000,000 *must* be expended, on the canal, to be a monument of our folly, [since the improvements in railroads, and the locomotive engine,] to procure only seven months, average trade by water, with the west, it is evident that other state works must stop for want of funds. It is equally certain, that if we expend thirty millions of dollars on the Erie canal, and eight millions on the Genessee valley and Black river canals, there will be no credit left to the State to even 'aid,' and certainly no funds to construct railways, by the State, as advocated by many. With this view of the subject, which we honestly believe to be correct, shall we be deprived of railroads, for intercourse with the interior, at all seasons of the year, and neglect a necessary class of improvements, to compete with our neighbors. A railroad from Albany to Buffalo will entirely relieve the Erie canal, of the semi-packet or line boats, that now takes up half the capacity of the Erie canal, with their lockages, and who do not carry on an average one-third of a load, yet with even this class of boats, that the railroad will soon drive from the canal, it is ascertained by official reports, that the down tonnage has decreased since 1835, and it is well known, that the up tonnage is only in the ratio of one to five for the down, and no enlargement will ever be required for the up tonnage, whilst railroads will greatly, if not entirely relieve the Erie canal from the down tonnage from the west.

"The enlargement," it has been shown, is not now required, and if persisted in, will defeat its great object, *cheap transportation.* This must occur from the rate of toll required to pay the interest on its cost, which we repeat *will exceed* thirty millions of dollars.

This is not all. The last winter's attempt to excavate frozen earth, ice and snow, between Albany and the Cohoes falls, and at Utica, has satisfied all those who have viewed it, that public opinion will not sustain this extravagant expenditure to the exclusion of aid and State patronage to railroads, on lines and sections of the country where canals cannot be constructed.

If we are to believe the report made last winter by a select joint committee of both branches of the legislature of Massachusetts composed of intelligent and practical men, who duly investigated the subject of railways, for transportation, as well as for passengers, this class of improvement in our northern climate, is superior to canals, inasmuch as the capacity of a well constructed and located railway, is considered superior to the Erie canal, celerity of motion, and use at all seasons of the year being considered. ☞ Railroads are destined, and must change the course of business and transportation, from the sea board.

It is gratifying to find that Mr. Edwards presents the view in your Journal of September, that the Philadelphia and Reading railroad can success-

fully compete with the Schuylkill canal, the best located for a profitable business in the United States, from its descending trade in coal. It has for several years yielded its original stockholders from 20 to 25 per cent per annum; and the stock has stood as high as $350 for 100 paid. Such now is public opinion in Pennsylvania; from their experience of the capacity of a well constructed railway to transport coal and merchandize, that even prior to the present pressure in the money market [the Schuylkill canal, runs side by side with the Philadelphia and Reading railroad,] that the canal stock has fallen from 350 to 170 per cent, in view of the competition that must take place. The importance of railroads for *general transportation*, entertained by Massachusetts, Pennsylvania and other States, should cause the next legislature of this State to examine into their merits. If this is done, we venture to predict, that the State report of 1835, comparing canals and railroads, adverse to the latter, will receive numerous corrections, by the facts in support of railroads now before the public derived from actual experience in this country and in Europe, since 1835.

ONTARIO.

EXTRACTS FROM THE REPORT OF TRANSACTIONS OF THE INSTITUTION OF CIVIL ENGINEERS.—March 5, 1839.

The President in the chair—"On the comparison between the power of locomotive engines and the effect produced by that power at different Velocities." By Professor Barlow, Hon. M. Inst. C. E.

In this communication the author attempts to lay down an appropriate method for computing the power of locomotive engines; and though this method will not serve to exhibit the absolute power of the engines, it may serve to exhibit the comparative power under different conditions.—We know the number of cubic feet of water evaporated in any given time; the space passed over in that time; the diameter of the driving wheels; the length of stroke, and the capacity of the cylinder; we hence know how many cubic feet of steam have been employed, and consequently the mean number of cubic feet of steam produced from one cubic foot of water. Again, by experiments that have been made by different writers upon the elastic force of steam, we know the pressure per inch on the piston, and then making due allowance for the resistance of the atmosphere on the piston, the friction of the engine gear, etc., there remains the force that ought to be effective on the piston. This being reduced to the circumference of the wheel, should be equal to the resistance opposed by the load, which on a level plane consists of axle friction, road resistance, and the resistance of the atmosphere to the engine and carriages. But this is assuming that the engine has a perfect action, without any waste, which, however much to be desired, can never be the case in practice. Thus comparing what ought to be done in overcoming resistance with what is done, we shall learn the amount of power wastefully expended.

The author then selects some experiments from those made on the North Star and Harvey Combe engines, as reported by Mr. Wood to the directors of the great werstern railway, and illustrates by these the proposed method and exhibits the results in tables.

From one of these experiments, it appears that the steam power expended per ton of the gross load amounts to 32 pounds, whereas on a tolerably level line it is generally assumed that the retardation of such a load does not amount to more than nine pounds per ton; so that there appears to have

been a power expended more than three times as great as the mechanical resistance to which it was opposed, according to views hitherto taken on the subject.

The author then proceeds to consider the resistance to railway trains at different speeds, and these resistances he refers to, 1st, that of the atmosphere. 2nd, the friction of the axles. 3d, the road resistance. He discusses several experiments made by Mr. Wood, and remarks on the great discrepancies which they present—the atmospheric resistance in one case amounting to 353 pounds, and in another to 99·7 pounds at the same velocity, viz., 32¼ miles per hour; the friction in the former case being five or six pounds, and in the latter twenty pounds per ton. The results of the best experiments on the atmospheric resistance and on friction show that the former must be considered to vary nearly as the square of the velocity, and the latter to be constant, or independent of the velocity; but this law of the constancy of friction, owing to the peculiar circumstances of the case, cannot hold with respect to to the axles of railway trains.

Very much must be attributed to the increase of the road resistance as due to the deflection of the rails at high velocities, and to the state of oscillation to which all the parts of the carriages are subject, and the imperfection of the joints. The author proceeds to make some observations on the actual state of our knowledge with respect to the atmospheric resistance, and the effect of inclined planes on the working of a line of railway. The speed in descending planes is limited by considerations of safety, and in planes of 1-96, 1-100 and 1-220, it is not safe to descend with heavy loads at a greater mean rate than is attainable with the same load on a level;—that on planes between 1-750 and a level the whole attainable speed is admissible.

The method of inferring the power of an engine from the quantity of water evaporated was objected to on the grounds that so much water is lost by priming.

With respect to the resistance due to the imperfection of the joints, it was remarked that engineers are generally so much restricted as to the expense of making the joints of rails, they cannot adopt that which is the best; and it is a question well worthy of attention, whether the best kind of joint is not the most economical, as the wear and tear would be diminished, and the comfort of the passengers increased, by attention to this point.

The experience of the Dublin and Kingstown railway showed that great advantages would result from a better kind of joint being used. This railway, though so short and only having been finished about three years, has had perhaps more frequent traversings than a longer railway would in fifteen years; the trains started every half hour, and frequently the departures were increased to every quarter of an hour: the opportunities of observing the effect of the carriages upon the rails were therefore excellent.

March 12, 1839.—The President in the chair.—"Description of the machinery and the several processes for converting refined metal into malleable finished iron at the Rhymney works." By Josiah Richards, Assoc. Inst. C. E.

In this paper the author explains and describes the elaborate drawing of puddling furnaces, forge and rolling mills, at the Rhymney iron works, presented by him last session to the institution, and the various processes necessary for converting refined metal into finished malleable iron. Each puddling furnace usually receives as a charge 4½ cwt. of refined metal, which is worked by the puddlers into six puddle balls in about an hour and a half. There are three sets of puddlers to each furnace, who relieve

each other every five charges. The puddled balls are drawn on wheeled trucks either to the hammer, weighing about 4½ tons, with a fall of 20 inches, where each receives about twenty-five blows, or to the squeezer; but this latter method does not get rid of the impurities so effectually as the former. The ball is then passed through a continually decreasing series of grooves in rollers, whereby it becomes puddled, or No. 1, bar. The bar is then cut into short lengths, allowed to cool, and made into piles of a particular weight and size, according to the description of the iron that is to be rolled; these being placed in a furnace are brought to a welding heat, and then passed through rolls and reduced to the requisite size, when they become No. 2, bar. The same operation of cutting, filing, heating, and rolling, being again gone through, the iron becomes No. 3, bar, or railway iron. No. 3 iron may be made from a pile, of which the top and bottom are of No. 2 iron and the middle of No. 1. It is then brought to a welding heat, and hammerd so as to be soundly welded; being again heated, it is rolled into No. 3, or railway iron.

The rail is received from the rolls on a carriage, and carried to a circular saw, where one end is cut off; the rail is then allowed to cool, and afterwards the other end is heated, and the rail cut to the required length.

March 19, 1839.—The President in the chair.—On Mr. Smeaton's "Estimate of animal power, extracted from his MS. papers." By John Farey, M. Inst. C. E.

The amount of mechanical power has been frequently overstated, in consequence of the conclusions being drawn from efforts continued for too short a time. Desaguliers estimated the power of a man as equal to raising 5507 pounds one foot high per minute: this was found by Smeaton to be too high; several experiments are recorded, in which different values are assigned to the power of a man, and he ultimately fixed it at about two-thirds of the above, or 3672 pounds. Several experiments are recorded of the estimate of the power of a horse and of the quantity of water raised by various machines.

The communication is accompanied by a letter in Mr. Smeaton's hand writing, dated 21st Feb., 1789.

"Account of the firing of gunpowder under water, by the voltaic battery at Chatham, March 16, 1839, under the direction of Col. Pasley." By F. Bramah, Jr., A. Inst. C. E., and C. Manby, A. Inst. C. E.

Exp. 1.—A tin canister containing 45 pounds of powder was sunk in deep water, and the coil containing the conducting wires one-fifth of an inch in diameter, by which the powder was to be fired, was veered out to its whole length of 500 feet from the boat in which the voltaic battery was placed. The connection being made, the explosion was instantaneous, and the concussion was felt very sensibly on the shore.

Exp. 2.—Three canisters, each containing a charge of five pounds, were sunk at a distance of 50 or 60 feet from each other, and a pair of connecting wires, 100 feet long, were attached to each; the ends of these wires were soldered together by threes, and on the connection being made only one of the canisters was fired. The wires in this experiment were of common copper bell wire, about one-sixteenth of an inch in diameter. The voltaic battery used, was one of Professor Daniell's improved construction. The preparation of the conducting wires, and the manner of discharging the battery, appeared the same as described in Mr. Bethell's communication of last session.

"Description of a machine called a Floating Clough."—By George Ellis, Grad. Inst. C. E.

The machine here described is used for scouring a channel which leads from the Winestead drainage and Haven of Pattrington, in the river Humber. It is constructed in the following manner:—The frame is made of timbers 6 inches by 4, 12 feet long, 9 wide, and 6 deep. This frame is covered with planking 2 inches thick, and through the middle of it a culvert is formed with planks, 2 feet 6 inches in width, with a small lifting door at one end. Connected with the bottom, and projecting in front, are two long beams called feelers, which keep the machine in its course, and in the front are frames of wood shod with rough iron like the teeth of a saw, and these are connected with racks which can be raise by a lever.

At each side of the machine there is a wing which is made to fit the slope of the banks, to dress the mud from the sides, and to keep up the water behind the machine.

At high tide the machine is moored in the middle of the channel, the wings are extended and kept so by ropes and when the tide is at half ebb the plugs are taken out, and the water rises about two feet in the machine, which causes it to sink; the plugs are replaced, and thus it remains till full ebb, when the iron-shod frames are let down in front, and the tide forces the whole machine, which is like a great dam, gently down the stream, scraping with it all the mud down to the river, where it is emptied, and floated back with the return tide. The whole distance, about three miles, is performed in two hours. A machine of the same kind is used with great advantage at Great Grimsby.

ON THE METHOD OF PRODUCING COPIES OF ENGRAVED COPPER-PLATES, BY VOLTAIC ACTION; ON THE SUPPLY OF MIXED GASSES FOR DRUMMOND'S LIGHT, BY ELECTROLYSIS; ON THE APPLICATION OF ELECTRO-MAGNETISM AS A MOTIVE POWER IN NAVIGATION, AND ON ELECTRO-MAGNETIC CURRENTS. BY DR. M. H. JACOBI: IN A LETTER TO MR. FARADAY.

It is some time since, that during my electro-magnetic labors, a fortunate accident conducted me to the discovery that we might by voltaic action make copies in relief of an engraved copper-plate, and that a new inverted copy of those in relief might be obtained by the same process, so that the power was obtained of multiplying the copper copies to any extent. By this voltaic process the most delicate and even microscopic lines are reproduced, and the copies are so identical with the original that the most rigorous examination cannot find the least difference. I send you in the accompanying packet two specimens of such plates, which I hope you will accept with kindness. The one which is in relief is the copy of an original engraved with the burin; the second is the copy of that in reilef, and consequently identical with the original. The third is the original plate, but covered with reduced copper. I had the intention of making a second copy, but unfortunately the plates adhere so strongly at times that it is impossible to separate them. I cannot tell the cause of this intimate union which occasionally occurs, but it appears to be the case only when the copper at the surface of which the reduction is effected is brittle, and consequently is lamellar and porous. I may dispense with describing more at large the apparatus that I make use of. It is simply a voltaic pair *a cloison* where the engraved plate is used in the place of the ordinary copper plate, being plunged in the solution of sulphate of copper. I have found it necessary that a galvanometer with short wires should always make part of the cir-

cuit, so that one may judge of the force of the current and direct the action; the latter being effected by separating the electro-motive plates more or less from each other or modifying the length of the conjunctive wire, or finally, diminishing, more or less, the conducting power of the liquid on the zinc side; but for the success of the operation it is of great importance that the solution of copper should be always perfectly saturated. The action should not be too rapid: from 50 to 60 grains of copper should be reduced on each square inch in 24 hours. The accompanying plates have been formed, one in two days the other in one day only, and that is the reason why their state of aggregation is not so solid and compact as that of the small piece, No. 4, which has been reduced more slowly.

It is to be understood that we may reduce the sulphate of copper by making the current of a single voltaic pair pass through the solution by copper electrodes; as the anode is oxidized the cathode becomes covered with reduced copper, and the supply of concentrated solution may then be dispensed with. According to theory one might expect that exactly the same quantity of copper oxidized on one side would be reduced on the other, but I have always found a difference more or less great, so that the anode loses more than the cathode gains. The difference appears to be nearly constant, for it does not augment after a certain time, if the experiment be prolonged. A thoroughly concentrated solution of sulphate of copper is not decomposable by electrodes of the same metal, even on employing a battery of three or four pairs of plates. The needle is certainly strongly affected as soon as the circuit is completed, but the deviation visibly diminishes and very soon returns almost to zero. If the solution be diluted with water to which a few drops of sulphuric acid have been added, the current becomes very strong and constant, the decomposition goes on very regularly, and the engraved cathode becomes covered with copper of a fine pink red color. If we replace the solution of sulphate of copper by pure water acidulated with sulphuric acid, there is a strong decomposition of water even on employing a single voltaic couple. The anode is oxidized, and hydrogen is disengaged at the cathode. At the commencement the reduction of copper does not take place; it begins as soon as the liquid acquires a blue color, but its state of aggregation is always incoherent. I have continued this experiment for three days, until the anode was nearly dissolved; the color of the liquid became continually deeper, but the disengagement of hydrogen, though it diminished in quantity, did not cease. I think we may conclude from this experiment that in secondary voltaic actions there is neither that simultaneity of effect, nor that necessity of entering into combination or of being disengaged from it, which has place in primary electrolytic actions.

During my experiments many anomalies respecting these secondary actions have presented themselves which it would be too embarrassing to describe here: in fact there is here a void which it will be difficult to fill, because molecular forces which as yet we know nothing of appear to play a most important part.

With respect to the technical importance of these voltaic copies, I would observe that we may use the engraved cathode, not only of metals more negative than copper, but likewise of positive metals and their alloys, [excepting brass,] notwithstanding that these metals, etc., decompose the salts of copper with too much energy when alone. Thus one may make, for example, stereotypes in copper which may be multiplied as much as we please. I shall shortly have the honor to send you a bas-relief in copper, of which the original is formed of a plastic substance, which adapts itself to all the wants and caprices of art. By this process, all those delicate touches are preserved which make the principal beauty of such a work, and which

are usually sacrificed in the process of casting, a process which is not capable of reproducing them in all their purity. Artists should be very grateful to galvanism for having opened this new road to them.

During the last winter I frequently illuminated my saloon, which is of considerable size, by Drummond's light. The mixed gasses were obtained in sufficient quantities, that is to say, at the rate of 3 or 4 cubic feet per hour, by decomposing dilute sulphuric acid [specific gravity 1·33,] between electrodes of platina by a constant battery of a particular construction. I only passed the gas through a glass tube filled with chloride of calcium, and there was neither gasometer nor any other provision for it. As soon as the voltaic current was closed the jet might be lighted, and the flame then burnt tranquilly, and of the same intensity for any length of time. The construction and manipulation of the battery, though extremely perfect, was still a little embarrassing. At present, a battery, with a decomposing apparatus which will produce from 3 to 4 cubic feet of electrolyzed gas per hour, occupies little more space than the page of paper on which I write to you [10 inches by 8 inches] and is about 9 inches in height. Behold certainly a beautiful application of the voltaic battery.

In the application of electro-magnetism to the movement of machines, the most important obstacle always has been the embarassment and difficult manipulation of the battery. This obstacle exists no longer. During the past autumn and at a season already too advanced, I made as you may perhaps have learned by the *Gazettes*, the first experiments in navigation on the Neva, with a ten-oared shallop, furnished with paddle wheels, which were put in motion by an electro-magnetic machine. Although we voyaged during entire days, and usualy with ten or twelve persons on board, I was not well satisfied with this first trial, for there were so many faults of construction, and want of insulation in the machines and battery, which could not be repaired on the spot, that I was terribly annoyed. All those repairs and important changes being accomplished, the experimenents will shortly be recommenced. The experience of the past year, combined with the recent improvements of the battery, give as the result, that to produce the force of one horse (steam engine estimation,) it will require a battery of 20 square feet of platina distributed in a convenient manner, but I hope that eight to ten square feet will produce the effect. If Heaven preserves my health, which is a little effected by continual labor, I hope by next midsummer I shall have equiped an electro-magnectic vessel of from 40 to 50 horse-power.

In my paper, "On the application, etc.," I have spoken of the influence which those magneto-electric currents which you had discovered a short time before, would exert on the progress of electro-magnetic machines. They are properly the cause that the expectations which have been entertained regarding these machines have not as yet been fulfilled. But if one examines them more nearly these currents are not so disadvantageous as have been supposed. Experiments which I have made by interposing a galvanometer or a voltameter have taught me that during the action of the machine the electrolytic action of the battery is much less, and sometimes not more than half that which takes place when the machine is stopped, the current still passing by the helices which surround the bars of iron. Thus if on the one part the magneto-electric currents diminish the force of the machine, on the other the electrolytic dissolution of zinc, which makes the greatest part of the current expense, is at the same time considerably diminished. I have not as yet succeeded in completely developing the mutual relations of the current before and during the working of the machine.

I take the liberty of sending you some memoirs from the *Buletin scientifique* of the Academy. The result of the joint memoir of myself and M. Lenz is *that the attraction of electro-magnets is as the square of the force of the current, or as the square of the electrolytic action of the battery.* It appears that this important law holds good for machines in motion; at least the experiments I have made on that point do not depart from it more than may be admitted as the error of observation or the result of accidental circumstances.

I am, &c.

St. Petersburg, June 21, 1839. M. H. JACOBI.

London and Edinburg Phil. Mag. for September.

ERIE CANAL.

Tonnage passing, and lockages at Alexander's Lock No. 26, three miles west of Schenectady.—Two tests, that the "more speedy enlargement" is entirely unnecessary.

First test.—The lockages at the most glutted point, Alexander's lock, will test the capacity of the Erie canal. If there were no locks on the Erie canal, its capacity would be illimitable. The locks make the delay, and the number of boats, the lock at the most glutted point will pass, is the test of the capacity of the canal. If the lockages increase at that point, the necessity of the enlargement increases; if the lockage diminish at that point, the necessity of an enlargement diminishes.

The following are the lockages at that point in the last four years.

1835	to September 1,	14,981	lockages.
1836	"	15,324	"
1837	"	10,711	"
1838	"	13,598	"

Second test.—The tons of moving matter, whether in boats or rafts, delivered at *tide water*, and the composition of such matter. This, while it furnishes another test, discloses the *reason why* the necessity of an enlargement of the canal, at the most glutted point diminishes.

In senate doc. No. 27 of 1839, statement No. 6, will be found a statement of the tons of property which reached tide water in each of the years from 1835 to 1838 inclusive, as follows:

	1835.	1836.	1837.	1838.
	Tons.	*Tons.*	*Tons.*	*Tons.*
The forest	540,202	473,668	385,017	400,877
Agriculture	170,954	173,000	151,469	182,142
Manufactures	8,849	12,906	10,124	8,487
Other articles	33,187	36,773	65,171	48,975
Total tons	753,191	696,347	611,781	640,481

Now this is what comes to the Hudson river over that part of the canal which does the most business. Let the reader examine the matter of which this down tonnage is composed. Two-thirds, or 66 out of 100 tons, is from the forest; from trees, boards, plank, etc. The most of the residue, is from agriculture—from the tillage of the earth, wheat, rye, corn, etc., and

from grazing—beef, pork, butter, cheese, etc. The decrease of the forest is 139,325 tons, The total decrease in four years, is 112,690 tons—equal to 15 per cent.

Now let the intelligent reader reflect. Will the forest, the trees, increase, *or* will they not rather continue to decrease faster than agriculture increases? Will not what has been, continue to be? If it will, then is the "enlargement," with *double* locks on the *whole line* unnecessary and unwise. If it is, even the doubling of the locks will not be necessary until by the diminution of the forest, and the increase of agriculture, the lockage at Alexander's lock shall exceed the lockages of 1836. ☞ The new double locks are equal to eight times the capacity of the present single locks.

The above views are taken from a writer in the Argus, and completely proves the position taken in this number, by

ONTARIO.

SPECIFICATION OF A PATENT FOR MANUFACTURING SUGAR FROM BEETS. GRANTED TO JOSEPH HURD, JR., OF THE CITY OF BOSTON, JULY 26TH, 1838.

To all whom it may concern: Be it known, that I, Joseph Hurd, Jr., of Boston, in the State of Massachusetts, have invented an improved mode of manufacturing sugar from beets, by which the process is so much facilitated as to enable every cultivator to perform it in his own family, with great economy and efficiency; the apparatus employed not being costly in the first instance, and the opperation being carried on, principally by means of such utensils as every farmer already possesses.

The beets, after being taken from the ground, and freed from all extraneous matter, are to be cut into slices the thickness of which shou'd not much exceed the eighth of an inch. I have invented a machine for the purpose of performing this operation, which is more effective than any other with which I am acquainted, and for which I have obtained letters patent of the United States. The beets are to be taken out of the ground as soon as they are perfectly matured, and are then to be stored in a cellar, or other suitable place, as otherwise they rapidly undergo a change unfavorable to the production of sugar; they are to remain in this situation until the arrival of the time for slicing and drying them. The propet period for this opperation is the earliest season of frost; as in my process, they are to be exposed to a freezing temperature, so as to freeze and dry them in the air immediately after they are cut. This freezing is an essential point in my process; this, together with the dispensing with the use of lime, and the producing of sugar without molasses, may be denominated its characteristic features. To dry the beets after slicing them, they may be spread out upon laths, or upon netting, or in any other manner in which they will be most completely exposed to the frost, and to the wind; the desiccation, when sliced as above directed, requires but a short space of time, and is effected without injury to the saccharine principle. After being thus frozen and dried, the subsequent steps of the process may be performed at any time, as not the slighest injury will result from keeping the beets in a dry state for any length of time.

When it is desired to proceed to obtain the sugar from the beets immediately, they may be subjected to the freezing process only, then thawed and

submitted to pressure; they will then readily yield the greater part of their juice, which they would not have done if pressed prior to their being frozen. The pressed slices, with the residuum of the sugar contained in them may afterwards be dried, and kept as food for cattle.

When the sugar is to be extracted from the dried beets, which may be done at any season, they are to be steeped in pure water, which will take up all the soluble matter, an effect consequent upon the change produced in the beet by freezing. The quantity of water need only be such as shall suffice to cover the beets, and may be about one-half of that which was lost in the process of drying. The soluble materials consist principally of the sugar, the mucilage, and a portion of coloring matter. To free the sugar from the mucilage and coloring matter, I generally acidulate the water before pouring it upon the dried beets, by adding to it a minute portion of sulphuric acid; the quantity of this cannot be easily designated, otherwise than by observing that it shall be no greater than shall suffice to render the acid taste just perceptible. Sometimes I add the water alone, and after allowing a sufficient length of time for it to take up all the soluble matter, which may be from three to four hours when cold water is used, but a much shorter period will suffice with hot water; I drain off, and press out the solution from the residual matter, and then add thereto the sulphuric acid, as before directed. In the former mode, but little of the mucilage and coloring matter is taken into solution; in the latter, they are precipitated, or so far disengaged from their combination with the sugar, that they separate in the form of scum, and are readily removed when the liquid is boiled.

The liquid thus prepared, is to be put into a boiler, and placed over a fire, a portion of the white of eggs, or other fining being added. When brought to a boiling heat, a scum will rise, which is to be removed after damping, or taking the kettle from the fire, which is to be repeated as long as any scum rises.

The next operation is to filter the liquor through animal charcoal, [ivory or bone black.] A stratum of two or three inches in thickness will suffice for every useful purpose, when the previous preperation has been used as above directed. The sirop will come through perfectly fine, and nearly as colorless as water; there will, however, be a very slight yellowish green tinge, resulting, apparently, from the presence of a peculiar principle in the beet; this material separates when crystallization takes place; although its quantity is minute, and its weight scarcely appreciable, it will if left among the crystals, occasion an adhesiveness of the particles, and a tendency to deliquescence; it should therefore be got rid of, and this is easily effected. All that is necessary is to pour a quantity of white sirop upon the crystallized sugar after it has been pressed, so as to moisten it throughout, and then press it again. This operation requires but little time, and should be repeated until the sugar is fit to pack.

The evaporating of the water from the sugar, preparatory to its crystallization, may be in great part performed over an open fire without danger of injury; it may be completed by placing the evaporating pan in a vessel of water kept at about 150° of Fahrenheit's thermometer. When this is performed early in the season, or by taking beets which have been frozen and dried at the proper time, there will not be the smallest portion of molasses produced, the whole of the sugar being crystallizable. In very cold weather, a large part of the water may be removed in the form of ice, by allowing it to freeze, and much labor and fuel be thus saved.

When the clarified sirop is sufficiently concentrated, small brilliant crystals will appear upon the sides and bottom of the vessel, and a crust soon

forms over the surface of the liquor; the crystals go on increasing in size, and that portion of the sirop from which the air is excluded continues in a perfectly clear and liquid state; but if the sirop be at this time stirred, it becomes opaque, and of milky whiteness; a deposition of fine white sugar then takes place, and whatever of impurity may have remained in the liquor will rise to the surface; this portion crystallizes more slowly than the other, but by drawing it off, and again exposing it to heat, it will readily form good sugar.

Having thus fully described the process which I pave devised for the manufacturing of beet sugar, I do hereby declare, that what I claim as my invention, and desire to secure by letters patent, is the preparing of the beets for the subsequent steps of the process, by exposing them, in thin slices, to the action of frost, after which they may be directly thawed, and submitted to pressure; or they may be dried by a current of cold air, and treated in the manner set forth, at any convenient time; it being always observed, that when the process for the extraction of the sugar is commenced, it must be completed without delay, as upon this depends the ability to produce the sugar without molasses, and without the employment of lime to correct acidity.

JOSEPH HURD, JR.

SPECIFICATION OF A PATENT FOR A PROCESS FOR ALLOYING METALS BY CEMENTATION; GRANTED TO M. SOREL OF PARIS IN THE KINGDOM OF FRANCE SEPTEMBER 12TH, 1838.

To all persons to whom these presents shall come, M. Sorel, of the kingdom of France, gentleman, sends greeting. Be it known that I, the said Sorel, have invented, constructed, made and applied to use, a new and useful process for alloying metals by cementation, applicable particularly to the preservation of copper, iron and other metals, and also operating a change in their outward appearance, and giving them more gloss; which process is specified in the words following, viz:—

The said process consists in alloying the surface, or even the mass of copper either with *zinc, tin, lead, or other metals more fusible than copper*, and capable of being alloyed with the same. These various metals may either be employed singly or in combination, but I have obtained the best results, in every respect, from the use of zinc alone. By an analogous process, I also alloy iron and other metals, as herein fully described and made known.

The mode of cementing zinc with copper may also be employed for the cementation of other metals; I begin by scouring the metal I wish to alloy, or cement; I surround it afterwards with pulverized charcoal and zinc.—The zinc is prepared for that purpose by forming an alloy between the said metal and iron, which alloy may be easily reduced into powder. Zinc minutely divided by other means may also be employed.

The copper thus surrounded, or covered, is placed in a furnace, where it is to be raised to a red heat, and the same temperature must be kept up during a longer or shorter period of time, according to the dimensions of the pieces of coper operated upon, and the depth to which it is desired to operate the cementation. It is however proper that the operation should not last too long, as, on the copper, there might then be formed a coating of brass, which would be liable to corrode, and to produce verdigris; which defect may be obviated in two ways—1st, by stopping the operation before the alloying between the copper and the zinc be completely effected, and 2d, by sifting pulverized zinc over the substances which cover the copper, a few minutes before it is drawn from the fire.

In the process of cementation, just described, instead of the pulverized zinc, thin sheets of zinc may be substituted or even lapis calaminaris. When it is not required that the cementation should penetrate deeply into the copper, this metal may be previously coated with zinc, according to the usual process of tinning, and then submitted to the cementing process as above described.

This process of cementation is applicable to all metals in the rough or the finished state such as copper, brass, bronze, melchoir or German silver and is of much importance in metallurgy. Among thousands of applications, may be mentioned the preservation of the copper sheathing of ships, the preservation of medals and other precious articles of bronze, the cleanliness, and consequently the salubrity, of culinary utensils.

It is worthy of remark that zinc, which by itself is so easily corroded by acids, becomes quite proof against sulphuric acid in the cold state, let it be ever so concentrated, provided the cementation of zinc and copper be stopped at the proper point to avoid the formation of brass; while on the other hand, zinc alloyed by fusion with one half or one third, of its weight of copper is dissolved by sulphuric acid as rapidly as if it were pure and unalloyed.

The application to iron of the process of alloying by means of cementation is to be next explained; this process preserves iron from rust, and moreover, gives to wrought, or to cast iron, the appearance of gold or of silver.

With an alloy of copper and zinc in different proportions, and by prolonging the operation, more or less, a gold or silver color is given to the iron operated upon. These colors are brilliant and lasting, and do not produce verdigris, and the metal resists the action of sulphuric acid more or less diluted with water. The process is a follows, and consists of two operations, which though analogous in their effects, are yet different from one another.

Firstly, the iron must be covered by immersion in the fused metal which is intended to be used as a coating: *secondly*, the iron must be alloyed by means of cementation, with the metal which has been thus made to cover it. This last operation, gives to the coated metal new properties, and renders its surface more smooth.

To coat iron with an alloy of copper and zinc, I melt about two parts of copper with three parts of zinc, and I dip in this alloy, while in a fused state, and covered with borax, or other suitable flux, the pieces of iron I wish to prepare. These pieces must be well scoured, or previously coated with zinc. If the pieces be very massive, they must be heated before being dipped in the fused metal. By way of lessening the quantity of borax necessary to the process, a saturated solution of this flux may be made, and brought to the boiling point, and the pieces are then immersed in this solution before being introduced into the fused metal. When extracted from the melted metal, the pieces of iron will not have yet assumed the color of copper, and their surface will be rough, but a second operation imparts to them the proper color, and removes the aspereties.

The second operation is a follows: the pieces of iron which have been submitted to the first operation, must be covered with powdered charcoal, and exposed to a red heat, for a longer or shorter space of time, according to the color and the result to be obtained. The iron is better preserved from rust when the operation is rapidly effected, but in that case the color is not so good.

The pieces of iron must be drawn from the furnace along with the charcoal which covers them, and in that state immersed in water, and allowed to cool.

The second operation may be effected in a reverberatory furnace.

The same process may be modified so as to dispense with the previous coating of zinc given to the iron; to effect this an alloy of zinc and copper is made with the same proportions of each metal, indicated for the first process. When cool, this alloy must be reduced to powder in a mortar, and a certain quantity of borax must be added. The pieces of iron to be operated upon, must be scoured, and covered with a greasy, or viscous substance, or merely wetted with water; they are next strewed with the pounded alloy and borax, and finally imbedded in powdered charcoal in the same manner as in the second part of the first process; they must be heated long enough to allow the excess of zinc to evaporate. It is easy to ascertain that the operation is terminated when only a small quantity of vapor escapes from the mass. The pieces of iron are then drawn from the fire and thrown, while red hot, and still covered with charcoal, into water. After this immersion, the iron is completely coated with copper, the brilliancy of which may be increased by dipping it into nitric acid containing a little soot; it may then be burnisned, polished, and even gilded exactly as if it were massive copper.

I shall finally describe a second modification of the process for alloying iron with another metal by cementation; first, scour the iron perfectly, immerse it in a solution of sulphate of copper, and let it remain therein during a greater or less period of time, according to the thickness of the copper coating which it is desirable to obtain; the copper precipitates on the iron, and when the covering is sufficiently thick, the pieces operated upon must be taken out of the solution and covered with very fine clay, softened in water; over this are strewed borax and zinc, pulverized and mixed together; instead of strewing borax and zinc powder in this way, a paste may be made with clay, borax and zinc powder, and the pieces of iron be covered with the same.

The pieces of iron are next to be buried in powdered charcoal, and exposed during a few minutes to a white heat. They may then be withdrawn from the fire, and they will be found to be covered with a coating of the alloy, containing a greater or less proportion of zinc, according to the proportion contained in the powder employed, and the duration of the process.

What I claim as my invention, and desire to secure by letters patent, is the manner herein described of cementing copper, and other metals, or mixture of metals, with zinc in the manner, with the limitations, and for the purpose set forth. I also claim the manner of protecting iron, by the process, or processes herein fully described and made known, together with such modifications of said process, or processess, as are substantially the same in their nature and effects. M. Sorel.

Norwich Railroad.—During the present week the rails will be laid from Norwich to a station in Pomfret, about thirty-three miles. The cars have pased for some time from Norwich to Killingly, twenty-six miles, and the amount of transportation has been found to exceed the estimates previously formed of its amount. From the nothern termination of the road, ten miles have been completed from Worcester to Oxford. Operations are carried on over the other portions of the road with vigor, by large companies of operatives. The loss of a ship loaded with iron sufficient for six miles of the road, although it will not occasion pecuniary loss to the corporation, may make some loss of time in the completion of the work; new materials may be procured by purchase, it is supposed, in this country; if so, the whole undertaking may be completed within a few weeks.—*National Ægis.*

LOCOMOTIVES APPLIED TO CANAL NAVIGATION.—The experiments for testing the substitution of locomotive engines for horses in the hauling of boats and vessels on canals, were repeated on the 11th instant, upon the experimental ground, prepared near lock 16, on the Fourth and Clyde canal. They were conducted, as before, under the superintendence of Mr. M'Neill, C. E.

At this trial there were present, the governor, part of the committee, and the manager of the Forth and Clyde canal company, and several professional and scientific persons.

The locomotive engine was the one which had been used in the previous experiments. It was attached, successively, to passenger boats, lightly and heavily laden; and to sloops, singly and two together. The passenger boats almost instantly attaining velocities of 16 and 17 miles per hour; and these were maintained with a very small expenditure of steam. The wave produced by this rapid movement of the boats through the water, was very different from that which has been observed in all velocities hitherto accomplished on canals, and altogether unlike the one which theoretical investigation had prepared us to look for. It did not undulate and rush along the banks but proceeded direct from the boat side to the shore, striking the latter at right angles, or very nearly so. It was by no means increased in an equal proportion to the increase of velocity, but on the contrary, when highest, was evidently less than that which the passenger boats ordinarily produce. The sloops varied from 70 to 90 tons, and were moderately laden, but their draught of water was not less than eight feet. They were hauled at velocities, the highest of which was limited to 3½ miles per hour. Much higher could have been given (as was actually done in the previous experiments,) but this was considered to be a rate which would never be desirable for this class of vessels to exceed.

In every case the results were perfectly satisfactory and fully confirmed those given by the experiments of the 21st and 22nd ultimo. They left no doubt that velocities suitable to every kind of vessel were easily attainable, that these velocities might range from 2½ miles to 20 miles per hour, and that when the machinery and management should be perfected, and have become familiar by experience, it was more than probable that 25 and even 30 miles per hour might be safely accomplished.

The decided success of this step, necessarily made under the disadvantageous circumstances attending a first essay, has induced the Forth and Clyde canal company to resolve that the principle shall be carried immediately into practice. This company will therefore attain the honorable distinction of introducing an improvement pregnant with the most beneficial consequences to inland navigation.—*Eng. Paper.*

THE GALVANIC TELEGRAPH AT THE GREAT WESTERN RAILWAY.—The space occupied by the case containing the machinery (which simply stands upon a table, and can be removed at pleasure to any part of the room) is little more than that required for a gentleman's hat box. The telegraph is worked by merely pressing small brass keys (similar to those on a keyed bugle,) which acting (by means of galvanic power) upon various hands placed upon a dial plate at the other end of the telegraph line, as far as now opened, point not only to each letter of the alphabet (as each key may be struck or pressed) but the numericals are indicated by the same means, as well as the various points, from a comma to a colon, with notes of admiration and interjection. There is likewise a cross (x) upon the dial, which indicates that when this key is struck a mistake has been made in some part of the sentence telegraphed, and that an "erasure" is intend-

ed. A question—such as the following—"How many passengers started from Dryton by the ten o'clock train?" and the answer, could be transmitted from the terminus to Dryton and back in less than two minutes. This was proved on Saturday. This mode of communication is only completed as far as the west Dryton station, which is about thirteen miles and a half from Paddington. There are wires [as may be imagined] communicating with each end, thus far completed, passing through a hollow iron tube, not more than an inch and a half in diameter, which is fixed about six inches above the ground, running parallel with the railway, and about two or three feet distant from it. It is the intention of the Great Western railway company to carry the tube along the line as fast as completion of the rails takes place, and ultimately throughout the whole distance to Bristol. —*English paper.*

How Holland was formed.—The manner in which the country has been rendered habitable to human beings, is one of the most surprising facts in physical geography. The whole of the territory, from the Texel to the north, to pretty nearly Calais on the south, comprehending a large part of Holland and Belgium, and part of France, is in almost all parts perfectly level, and if it had not been indebted to art, would have been a general marsh, or included within the influence of the sea. On looking at this extensive territory, and then proceeding inland to the higher regions of Germany, the conclusion naturally arises, that the whole of the low countries are simply an alluvial deposit, washed from the alpine regions of the interior. The land every where on being dug, is sand or clay. You may travel hundreds of miles and never see a stone. At this hour land is forming on the coast of Holland, and by a very obvious process. The waters of the Rhine, in all its branches, are very muddy, or loaded with particles of clay and sand, washed from the upper country, and these are carried out to the sea, where they are sinking to the bottom, and forming sand banks. At the mouth of the Maese, long sandy beaches, produced in this manner, are seen at certain states of the tide. Already they exhibit tufts of herbage, and are resorted to by flocks of sea-birds; and there can be no doubt, that, by a very little trouble, many square miles of new land might at present be added to the coast of Holland. The exact process by which the low countries have been saved from the sea, has never yet been fully detailed. Nature having in the first instance produced an alluvial marsh, a certain degree of art has been employed to raise barriers to prevent the influx of the sea; and this point being secured, the next step has been to drain the land, piecemeal by pumping, the water being raised so as to flow off by channels into the sea at low tide. Much stress is usually laid by writers on the prodigious trouble taken by the Netherlands to keep out the sea, by means of artificial bulwarks along the coast. But on this point there is some exaggeration, and one very material circumstance is entirely omitted to be noticed. It is only at certain places that great exertions are made, by means of artificial dykes, to keep out the sea. Nature, as if anxious to save the country from tidal inundation, has for centuries been energetically working to increase the magnitude of the mounds on the coast. At low water, when the bare beach is exposed to the action of the winds from the German ocean, clouds of sands are raised into the air, and showered down upon the country for at least a mile inland; this is constantly going on, and the result is that along the whole line from Haarlem to about Dunkirk or Calais, the coast consists of sandy mounds or downs, of great breadth partially covered with grass and heath, but unfit for pasturage or any other purpose. In some places those downs look like a series of irreg-

ular hills, and when seen from the tops of the steeples, they are so huge as to shut out the view of the sea. The traveller in visiting them from the plains all at once ascends into a region of desert barrenness. He walks on and on for miles in a wilderness such as might be expected to be seen in Africa, and at last emerges on the sea shore, where the mode of creation of this singular kind of territory is at once conspicuous. Loose particles of sand are blown in his face; and as he descends to the shore, he sinks to the ancle in the drifted heaps. In some parts of these dreary solitudes, the sandy soil has been prevented from rising with the wind and injuring the fertile country, by being sown with the seeds of a particular kind of benty grass, and in a few spots fir trees have been successfully planted.—*Chamber's Continental Tour.*

SPECIFICATION OF A PATENT, GRANTED TO WILLIAM DOLIER, FOR A CERTAIN DURABLE SURFACE OR TABLET FOR THE PURPOSE OF RECEIVING WRITINGS, DRAWINGS, OR IMPRESSIONS OF ENGRAVINGS, OR OTHER DEVICES CAPABLE OF BEING PRINTED, WHICH SURFACES MAY BE APPLIED FOR ROADS OR PAVEMENTS, AND STRENGTHENING AND BEAUTIFYING GLASS.

My invention of a certain durable surface or tablet, for the purpose of receiving writings, drawings, or impressions of engravings or other devices capable of being printed, consists, firstly, in the application of a well known composition or material as a durable tablet or surface for receiving writings or drawings, and which may be removed at pleasure by moisture.

This composition or material is common glass enamel, made in the ordinary manner from flint glass, borax and arsenic, and which I roll out in thin plates of any required dimensions, exactly similar to manufacturing plate glass; and after it has been ground and polished, I remove the glazed surface by grinding with the finest emery powder, and then the tablet is ready for use. This permanent tablet will now be found capable of receiving the finest writing or drawing, and also beautifully adapted to receive paintings and impressions, exactly in the same manner as ornamenting china by painting or transfer.

This improved tablet will be an elegant appendage to various domestic purposes and furniture, and may be manufactured into sideboards, billiard tables, table tops, and all other similar ornamental purposes; and may have either a highly polished, or a dead surface, and may be composed of any variety of colors by altering the ingredients of the enamel, which is well understood.

My second improvement in a durable surface, is in rendering the same perfectly pliable, and still rendering such surface durable. This is composed by a foundation of a sheet of linen, silk, cotton or other cloth, linen being preferable, to be coated, or covered upon one side with a mixture, or composition and treated as follows:—spread upon the reverse side of the sheet of linen, one coat of a size or varnish, made by dissolving one pound of buffalo skin in one gallon of water over a slow fire, and let the other side, when dry, be rubbed with pumace stone, in order to remove all inequalities and leave the surface perfectly smooth. This surface is now to be coated three times with a mixture of the purest white lead, called flake white, with boiled linseed oil and spirits of turpentine, in about the proportions of one pound of white lead to one quart of oil and half a pint of turpentine. After this has become perfectly dried, the flexible surface is ready for use, and is most suitable for printing, and particularly advantageous for receiving impressions of maps or charts for marine and general purposes,

as being permanent and durable. The back, or reverse side of this prepared cloth may be flocked with pulverized woollen cloth in the usual manner of flocking paper hangings, which will improve its appearance and make it more suitable for ornamental purposes. Gold, silver, or bronze surfaces may also be given to the cloth thus prepared, by giving it a coat of the buffalo size, and dusting the metalic powder over it.

Thirdly, these improvements are applicable to roads and pavements for bath rooms and other similar situation, or tesselated pavements, where damp or wet is liable to get between the joints of the pavements, and form unhealthy and improper secretions; and consist in putting together squares of such enamelled surfaces as first above described, or common bath tiles in squares in different colors and devices, and cement or cover the joints with a light coating of glass enamel fused over the joints in order to render them perfectly secure; and in all situations where cleanliness and beauty are required, this will be found particularly useful.

A further application of this invention may be made by having engraved or printed maps, or other designs, made upon the under side of plates of glass, and vitrifying the glass to render the design permanent, and paving rooms with such plates or squares for the purposes of recreation; and also by inserting rails of glass, either in bars, rods, or plates set edgeways in grooves or sleepers of wood or metal, making such rails either portable or permanent, and also intended as applicable to various amusements which may thus be pursued in gardens or other situations.

The fourth feature in my invention relates to the strengthening and beautifying glass, and consists in preparing sheets or plates of glass in the usual manner, and placing between two plates a metalic web of wire, wrought into any form or design that may be desired, and then partially fusing the glass so that the glass shall run between the meshes or interstices of the metallic design, and thus consolidate or embody the whole into one plate of glass, with the metallic design in the centre.

The metallic web or design may be formed of either plain net, or any other elegant scroll work or other design, and be composed of brass plated, or other metalic wire, and cast into any form or device which shall be required, and the glass fused around it, and rolled or pressed in the ordinary manner of manufacturing plate glass.

Another adaptation of these improvements is particularly applicable to ornamental windows and casements, where the glass is not required to surround the metal upon all sides. A suitable casting is to be prepared in brass, iron or other metal, of the exact form of the window frame required; for instance, an ornamental Gothic window, and this casting is to be the frame work of the window. The glass is then to be cast in its fluid state into the metallic framing, and may either be rolled of such a thickness that the metal frame shall be in the centre of the plate of glass, or it may be rolled down until the glass shall only fill the interstices of the metalic framing; and thus in in either case, the whole of the panes or compartments of an ornamental window may be made in an entire piece, and of any variety of form, strength, or beauty. The glass is afterwards to be annealed in the usual manner, and then submitted to a bath of cold linseed oil, which is to be caused gradually to boil, and after removing from the fire and allowed to cool, which will thus form a second annealing, and also regulate the expansion and contraction of the metals. The glass is to be ground up and polished in the usual manner, and may either be made bright for windows or rendered opaque to be employed for all useful and ornamental purposes for furniture, to be used instead of the finest marbles, and with equal beauty and effect.

This combination of metals with glass, for the purpose of increasing its strength, will be of material importance for "dead lights" for all marine purposes, and also forming perpetual window blinds; and it will be evident that great strength may thus be given to glass for windows and such similar purposes by either of the processes above described.—*London Journal of Arts and Sciences.*

SPECIFICATION OF A PATENT GRANTED TO EUGENE RICHARD LADISLAS DE BREZA FOR A CHEMICAL COMBINATION OR COMPOUND FOR RENDERING CLOTH, WOOD, PAPER AND OTHER SUBSTANCES INDESTRUCTIBLE BY FIRE, AND ALSO PRESERVING THEM FROM THE RAVAGES OF INSECTS.

The chemical compound alluded to in the title of this patent, consists of the following materials, and is mixed in the following proportions:—for linens and unbleached goods, take two pints and a half of water, and after raising the temperature to 190 degrees of Fahrenheit's thermometer, add one ounce of alum, with one ounce and a half of sulphate of ammonia, half an ounce of boracic acid, one drachm of glue, the best and finest that can be procured, and add to the whole one drachm of starch dissolved in a small quantity of water.

Before the starch is added, the temperature of the mixture should be raised to at least 212 degrees of Fahrenheit; care should be taken that the several ingredients are introduced in the order above mentioned, and also that each one is dissolved in the water before the next is added. The mixture being thus prepared, the goods to be preserved are operated upon in any suitable manner; for instance, plain unbleached goods may be immersed in the compound, and be allowed to absorb as much as possible, after which they must be pressed or rung hard, in order to get rid of the redundant liquor; they are then dried in any convenient manner. Printed goods when the colors are fast, may be treated in the same manner; but when the colors are not fast, the mixture should be applied with a sponge, care being taken that they are not wetted too much, otherwise the colors may perhaps run.

When timber is to be operated on, it is to be put into tanks, and covered over with the mixture, which is raised to a temperature of at least 160 degrees.

For preserving paper, or pasteboard, the mixture may be put into the vat containing the pulp from which the paper or pasteboard is to be made, or, the paper may be immersed in the mixture after it is manufactured.

When the invention is to be applied to theatrical scenery already in use, sheets of paper prepared in the manner described, should be pasted at the reverse side; but for new scenery, the canvass may be steeped in the solution.

It is observed that it is not to be supposed the said composition will render the various articles indestructible by fire, but that it merely prevents them from bursting into flame, and by that means communicating the fire from one thing to another.

In conclusion the patentee states that he is aware that some of the ingredients above mentioned have been used for similar purposes to those which his invention is intended to be applied; but what he claims as his invention, is the making a composition consisting of alum, sulphate of ammonia, boracic acid, glue and starch, mixed in the above order and proportions, to be applied to various articles, and which composition will render them indestructible by fire, and protect them from the ravages of insects.—*Idem.*

SPECIFICATION OF JAMES CALDWELL, IN THE COUNTY OF MIDDLESEX, COAL-MERCHANT, FOR CERTAIN IMPROVEMENTS IN CRANES, VESSELS, AND APPARATUS FOR DELIVERING COALS FROM SHIPPING TO WHARFS, WAREHOUSES, WAGONS, AND OTHER PURPOSES.

The invention specified consists in a certain arrangement of mechanism, by means of which two men will be enabled to raise about nine hundred weight of coals at one time from the hold of a vessel, and deposit the same in a cart; parts of such mechanism, together with the weight of the men acting as a counter-balance, and facilitating the delivery of the coals or other burden.

The peculiar arrangement of parts for effecting this will be understood from the following description:—An upright standard or pillar, properly and firmly secured both at top and bottom, is affixed to the deck of a ship, or in any other convenient situation, and upon one side of this pillar a toothed rack is formed. A moveable platform is connected to the pillar in any convenient manner, and slides up and down in a groove formed on it. A pinion, which is mounted in some part of the moveable platform, gears into the toothed rack formed on the pillar; and to the axle of this pinion a winch handle and brake wheel is attached. A rope, connected to the moveable platform, is passed over a pulley mounted at the top of the pillar, the reverse end of the rope being fastened to the coal box below. Two ratchet racks, having clicks connected to the platform taking into them, are placed one on each side of the toothed rack before mentioned, in order to prevent the platform from running down, and to retain it in any elevation that may be required.

When the machine is required for use, the men on the platform turn the winches in order to raise themselves to such an elevation as will lower the coal box to the required depth in the hold; and when the box is full they turn the handles the reverse way and begin to descend, and, consequently, raise the coal box.

It will be readily understood that if the weight of coals to be raised is nine hundred weight, and if the moveable platform with its appurtenances, together with the men, weigh five hundred weight, then the power to be employed need not exceed that required to raise four hundred weight in the ordinary manner, as the weight of the platform and the men will materially assist the ascent of the coal box.

The box for containing the coals is so contrived that the bottom may be moved or tilted up, so that the coals may drop through; and according to the drawings, it seems to be divided into four compartments, probably for convenience of filling sacks. The first part of the invention may be applied to raising other weights.

SIDE MOTION (OR ROCKING) OF RAILWAY ENGINES EFFECTUALLY PREVENTED.

SIR.—My attention having been drawn to the lateral and shaking motion of engines upon railways, and believing it to be in proportion to the weight of the cranks and gearing, and the position in which the outside cranks, if any are placed, I made a small model of the engine crank shaft with two wheels upon it, in the proportion of one inch to the foot, which I placed upon two strong upright wires, the wires made fast in a piece of board. I attached a weight to a string wrapped round the middle of the crank shaft, for the purpose of giving a certain degree of velocity to the crank and wheels, by falling a certain distance, say from the table to the floor. The weight I attached would turn the shaft and wheels seventy-five seconds,

and the swing of the cranks produced *a lateral and oscillating motion* sufficient to cause the model to move, or jump, across the table on which it was placed. I then placed a weight on each wheel sufficient to *balance the cranks*, and with the same weight to give motion, and travelling the same distance as in the first case would turn the crank shaft and wheels, although heavier than before, 90 seconds, and the model stood steady where it was placed upon the table.

I submitted my experiments to the engineers of the London and Birmingham railway, who, instructed by the directors, ordered one of the company's engines [the Brockhall, at that time under repair at Mr. Middleton's the Vulcan iron foundry, Birmingham] to have ballance weights applied to it, according to my plan, and under my superintendence. The engine, when set to work, with the ballance weights on the wheels, had one uniform steady pull at its work; the side sway was gone; it run equally steady whether it made 6 or 160 strokes per minute, which is not the case with railway engines generally, for the greater the speed, the greater the snatching and swinging motion. After the engine had worked seven weeks, and had acquired the reputation of a very steady engine, I, with the consent of the engineers of the railway, removed the *balance weights* from the wheels and found the same snatching and swinging motion with this engine as is common to all locomotive engines of the usual construction; I found that the engine, when running at or upwards of 22 miles per hour, would advance and recede from and to the tender from three-quarters of an inch to an inch every stroke of the engine and proved the advantage of the ballance of the engine equal to the effect on the model. Persons acquainted with railway locomotion will from the foregoing statements readily see the great and many advantages to be derived from so simple and yet so effective an arrangement.

Yours respectfully, G. Heaton.

P. S.—Since writing the above, I understand the spirited and enterprising manufacturers of the Brockhall engine, have judiciously applied my balance weights to some new locomotive engines lately sent out by them.—*London Mechanics Magazine.* G. H.

THEORY OF THE STEAM-ENGINE.

CHAPTER I.—PROOFS OF THE INACCURACY OF THE ORDINARY MODE OF CALCULATION.

Section I.—Mode of calculation now in use, to calculate the effects of a steam-engine.

The object of this work is to demonstrate that the calculation of the effects or the proportions of steam-engines, either as it is practically used or as it is found indicated by authors who have treated this subject, is completely erroneous, and to develope a new theory which leads to accurate results. Our first chapter, then, will necessarily be devoted to proving the inaccuracy of the ordinary methods of calculation. From that we shall pass successively to the development of the theory proposed, and its application to the different systems of steam-engines in use.

The effect produced by a machine consists of two elements: the resistance set in motion, and the velocity communicated to that resistance. Hence results, that the calculations which first occur in the application of machines refer to the two following problems:

1st. The machine being supposed constructed, and the velocity of its motion given, to determine what resistance it can move.

2d. The machine being supposed constructed, and the resistance it has

to move being known, to determine the velocity it can communicate to that resistance.

A third problem then presents itself as a natural consequence of the two preceding, viz. :

3d. The resistance being known as well as the velocity to be communicated to it, to determine the dimensions that ought to be adopted in the construction of the machine, in order to produce the effect proposed. In steam-engines, this third problem reduces itself to determining the size of the boiler, or, in other words, the evaporation it should be capable of, in order to obtain the effect proposed.

These three problems are the basis of all calculations on steam-engines. They may take divers modifications and give rise to several questions, which hereafter we shall notice, but whose solution will entirely depend on that of the three fundamental problems just mentioned. Thus, for instance, to find the useful effect of an engine of which the number of strokes of the piston is counted, that is, whose velocity is known, amounts to determining the resistance it can move at that velocity; since that resistance being once known, it suffices to multiply it by the given velocity, to have the useful effect required. The horse-power of an engine, and its effect for a given weight of fuel, being nothing more than the useful effect of the engine referred to particular units; that is to the power of the horse considered as the unit of force produced, or to the consumption of a certain quantity of fuel considered as the unit of force applied; it is plain that these questions merge into that of the useful effect. This point, however, will be readily recognized when we come to treat specially of these questions.

Thus all inquiries relative to steam-engines reduce themselves finally to the three just announced: to find the load, to find the velocity, to find the evaporation.

The only mode of calculation hitherto in use to estimate either the effort of which a steam engine is capable, or the useful effect it can produce, is first to perform the calculation under the supposition that the steam acts in the cylinder with the same elastic force as in the boiler, and without regarding the friction of the engine; then to reduce the result in a certain proportion indicated by a constant coefficient. This method, which we shall name the method of *coefficients*, was resorted to, because there being no means of knowing, *a priori*, the pressure of the steam in the cylinder, it was naturally enough at first concluded to be equal to that of the boiler. But as the result thus obtained, and which was called the *theoretic* result, was invariably found much higher than the *practical* results compared with it, a reduction was found to be necessary.

The necessity of this reduction was attributed to two causes: 1st, to the friction of the engine having been neglected in the calculation; and 2nd, to no account having been taken of losses resulting from the five following circumstances: the contraction of the passages through which the steam has to pass, the changes in the direction of the conducting pipes, the friction of steam in the steam-pipes, the waste of steam, and its partial condensation. And as these causes seemed likely to act similarly, not only in the same engine, as long as the passages of the steam were not varied, but in all engines of the same system, it was natural to suppose that they would produce on the definitive result of the calculation, a reduction proportioned to its total value.

It was in consequence judged, that the real result might be attained by reducing the theoretic result in a certain constant proportion. It had been observed, also, that the ratio of the theoretical and practical effects was not

the same in the different systems of steam-engines; this consequently led to the admitting of a different coefficient for each system.

This mode was the most natural, it was even the only one possible, so long as means were wanting to determine beforehand what would be the real pressure of the steam in the cylinder under given conditions. And notwithstanding we have undertaken to demonstrate the errors which result from the application of that calculation, and to substitute another in its place, we are far from wishing to depreciate the works in which that calculation is developed. It was felt, no doubt, that that method, from the very circumstance of its consisting in the use of a coefficient to represent in total, various effects which had never been submitted to direct admeasurement, could be but an approximation, a mere provisional method. It was used as we use a bad instrument, till we can get a better. Many of the works wherein it is explained, acknowledge at the same time that the theory of the steam-engine is as yet unknown, or imperfectly studied. Moreover, these works do not all treat the subject in a manner perfectly similar, and therefore the observations we are about to make, cannot be addressed equally to all. We wish it, then, to be clearly understood, that in comparing the two calculations together, when it shall be needful so to do, our end is to establish the accuracy of the method we propose, and not to attack the writings of others.

To return to the method in use, this was the proceeding. The force applied to the piston was computed, in supposing the pressure of the steam in the cylinder equal to that of the steam in the boiler: that is to say, the area of the piston was multiplied by the pressure of the steam in the boiler, which gave the force exerted by the engine; this result was then multiplied by the velocity of the piston, and thus was obtained the *theoretic* effect of the engine. But the result of this calculation having been compared with that of some experiments made on engines of the same kind, the ratio between the two results had furnished a fractional coefficient, which was regarded as the constant ratio between the theoretical and practical effects of all engines of the same system; therefore, in multiplying the number expressing the theoretic effect by this fractional coefficient, a definitive product was obtained, which was the *practical* effect that could be expected from the engine.

Supposing, for instance, an engine without condensation, and expressing the area of the cylinder by a, the pressure of the steam per unit of surface in the boiler by π, and the velocity of the piston by v; $a\pi$ was the force applied by the engine, and $a\pi v$ the theoretic effect it ought to produce. As then some experience, instead of giving an effect equal to $a\pi v$, had given but a certain fraction of it, which we will express by k, the coefficient k was admitted as representing the constant ratio between the theoretical and practical effects. So that the useful effect of a non-condensing engine was represented by $ka\pi v$; or the theoretic effort of the engine being expressed by $a\pi$, its useful effort, or the resistance the piston could move, was represented by $a\mathrm{R}=ka\pi$, R expressing that resistance supposed to be divided per unit of the surface of the piston.

The coefficients indicated by Tredgold, in order to pass from the pressure in the boiler to the part of it which is applied to produce the useful effect, are the following:

Non-condensing unexpansive engines	·60
Non-condensing expansive engines	·60
Non-condensing expansive engines, with two cylinders	·47
Watt's single-acting engines	·60
Single-acting expansive engines	·60
Watt's double-acting steam-engine	·63

Double-acting engine, with two cylinders ·48
Atmospheric engine (coefficient to be applied to the atmospheric pressure, and including a deduction for the pressure of the uncondensed steam on the opposite side of the piston) ·52
Atmospheric engine, with a separate condenser (coefficient to be applied like the preceding one) ·54

It must be understood that these coefficients, excepting those for the atmospheric engines, are to be applied to the *total* pressure of the steam in the boiler; that is, before any deduction is made, either for the pressure of the uncondensed steam or for the atmospheric pressure, on the opposite side of the piston. If, on the contrary, before applying the coefficient, the pressure in the boiler had been diminished by the pressure subsisting on the other side of the piston, in order to deduce first what is called the *effective* pressure of the steam, then other coefficients, smaller than those indicated here, ought to be used. For instance, if we suppose a high pressure steam-engine working at the *total* pressure of 65 lbs. per square inch, and that we apply to that pressure the coefficient ·60, we shall have for the useful part of the total pressure $65 \times \cdot 60 = 39$ lbs.; and if we deduct from this force, the atmospheric pressure which acts on the other side of the piston, the practical effort applied by the engine will be $65 \times \cdot 60 - 15 = 24$ lbs. But as the *effective* pressure of the steam in the boiler is $65 - 15 = 50$ lbs., it is clear that, if we had had to pass from the *effective* pressure of the steam to the practical effort applied by the engine, a coefficient of ·50 ought then to have been used, instead of the coefficient ·60 applied to the *total* pressure in the boiler.

It is to be remarked also, that, as the theoretic effect of an engine is known only after deduction of the pressure on the other side of the piston, it follows that if the theoretic effect of the engine had been definitively calculated by this mode, and that we were to pass from it to the practical effect, it is the coefficient ·50 which ought then to be employed. Therefore, this last coefficient indicates in reality the reduction operated upon the *theoretic effects*, to conclude from them the *practical effects* of the engine; but the calculation comes to the same either way, provided a suitable coefficient be used.

Such was the solution of the first of the three problems above mentioned. The second, which consists in determining the velocity, had not been the object of any inquiry, by the mode of reasoning we have just exposed.

The third problem, or the evaporation of water necessary to produce a given effect, had been solved in a manner similar to the first. The rule consisted in calculating the volume described by the piston, and in supposing that volume to have been filled with steam at the same pressure as in the boiler, and then applying to it a constant coefficient. That determined in the preceding problem was usually employed, but it was applied as a divisor, with a view to augment the evaporation in proportion to the losses represented by that coefficient.

Thus, retaining the foregoing notations, and expressing by m the volume of steam formed at the pressure of the boiler referred to the volume of water that produced it, we perceive that the volume described by the piston during the unit of time, was av. From the signification of the letter m this volume of steam represented a volume of water expressed by $\frac{av}{m}$; but as it was deemed subject to a loss represented by the fraction or coefficient k, the volume of water really necessary to supply the expenditure $\frac{av}{m}$, became

$$S = \frac{av}{km}.$$

Such was the calculation in use; it solved, as we have seen, only two of the three fundamental problems. We shall, at a future moment, return to what regards the velocity of the piston under a given load.

Besides what has been said, the received ideas relative to the pressure of the steam in the cylinder, consisted in deeming that, the pressure in the boiler being given and fixed, it were possible at pleasure to vary the pressure in the cylinder and to produce there any desired pressure, provided it were inferior to that of the boiler, by contracting more or less the orifice of the steam-passages; and it was thought that, when this orifice was entirely open, with the area usually given to it in fixed engines, to wit, $\frac{1}{25}$ of the area of the cylinder, the pressure of steam in the cylinder could differ but in an inconsiderable quantity from the pressure in the boiler.

However, as the *indicator* of Watt, applied to the cylinder of several engines, had demonstrated a certain diminution of pressure therein, when compared with the pressure in the boiler, the authors who took this fact into account, without perceiving its real cause, still attributed it to the circumstances already explained, and it became merely one of the elements in the explication of their definitive coefficient. Thus, in all cases, the pressure in the cylinder was considered as being equal or proportional to that in the boiler, and therefore constant, so long as no change took place in the pressure of the boiler; but in no wise as being regulated by the resistance, or as variable with the resistance, independently of all pressures in the boiler, which we shall demonstrate that it in reality is.

Section II.—Objections against that mode of calculation.

The objections which first present themselves against that mode of calculation are the following:

1st. The coefficient adopted by many to represent the ratio of the theoretic effects to the practical, in high-pressure engines, was ·33; which was explained by saying that the remainder, or ·66 of the total force developed, was absorbed by the frictions and losses. Not that these frictions and losses had been measured and found such; but merely that the calculation, which might be inexact in its very principle, wanted so much of coinciding with experience.

To obtain conviction of the impossibility of justifying such an assertion as to the value of the frictions and losses, it suffices to peruse the explanation of it attempted by Tredgold, who follows this method.

He indicates that a deduction of 4 tenths should be made on the *total* pressure of the steam, (including the atmospheric pressure,) which amounts to making a reduction of ·5 on the ordinary *effective* pressure of those engines, or to using a coefficient of ·5 applied to the theoretic effect of the engine. He thus explains this loss in the effect produced.*

Force necessary to bring the steam into the cylinder	·007
Force necessary to drive the steam into the atmosphere	·007
Loss from cooling in the cylinder and in the pipes	·016
Friction of the piston, losses, and waste	·200
Force necessary for the opening of the valves and the friction of the different parts of the engine	·062
Loss in consequence of the steam being intercepted before the end of the stroke	·100
	·392

Reflecting that the numbers here given express fractions of the *total gross* power of the engine, we shall immediately be convinced of the im-

* Tredgold, Treatise on Steam Engine, Article 367.

possibility of admitting such estimates. If, for instance, the engine had a *useful* effect of 100 horse power, which, from the coefficient, supposes a gross effect of 200, it would require the power of 12 horses to move the machinery, of 40 to draw the piston, etc. The exaggeration is self-evident.

Besides, in applying this estimate of the frictions to a locomotive engine, which is also a high pressure engine, and supposing it to work at 60 lbs. effective pressure, or at 75 lbs. *total* pressure per square inch, we perceive that, were the cylinders 12 inches in diameter, or their surfaces 226 square inches, the force here reckoned as representing the friction of the piston would be $226 \times 75 \times \cdot 20 = 3390$ lbs. Now, our own experiments on the friction of the mechanical organs of the locomotive engine the *Atlas*, which has those dimensions and which works at that pressure, demonstrate that the force requisite to move, not only the pistons, but all the other mechanical organs, including wastes, if it be true that such exist in an engine in good order, is but 48 lbs. applied to the wheel, or $48 \times 5 \cdot 9 = 283$ lbs. applied to the piston.*

It is impossible, therefore, to admit estimates so exaggerated as these; and what will it be, when it becomes necessary to explain a loss, not merely of half, but of two-thirds of the effect produced, as required by the coefficient ·33, adopted by many in practice, particularly for locomotive engines?

2d. This deduction, moreover, of two-thirds, considerable as it is, in very many cases does not suffice to harmonize the practical effects with the effects called theoretical.

In Wood's treatise on railroads, second edition, pp. 277—284, appears the calculation of five steam engines, not locomotive but stationary, two working at low pressure and three at high pressure, in which the real effects are to the theoretic, in the proportions represented by the following coefficients: ·26—·29—·31—·27 and ·30. Here then are examples, wherein it would be necessary to explain a loss of three-fourths of the total power of the engine.

But, with respect to locomotives, the difficulty becomes still greater, for it often occurs, when the load of the engine is light, that it would be necessary to apply a coefficient less even than ·25; and yet in these engines the steam passages have an area of $\frac{1}{10}$ instead of $\frac{1}{25}$ of the area of the cylinder; they are immerged in the steam of the boiler itself, which precludes all possibility of waste; the cylinders are in contact with the flame issuing from the fire-box, which entirely prevents condensation. Thus there remains only the friction to explain the enormous loss sustained, of more than ·75 of the total power; and this friction measured in our own experments, as will be seen farther on, never rises above ·18 of what is termed the theoretic effect of the engine.

3d. It has just been said that, in locomotive engines, the coefficient would in certain cases sink below ·25. But there are other cases on the contrary, wherein, for the same engine, it would rise to ·80, examples of which may be seen in our *Treatise on Locomotives*, in all the cases when the engine drew a heavy load. Thus all the loss hitherto so laboriously explained disappears on a sudden.

4th. The measure of the theoretic effect of the engine results from three elements, to wit: the surface of the piston, the pressure of the steam, and the velocity of the motion. The causes which are said to explain the reduction to which this theoretic effect is liable, are: first, the friction of the engine, then the contraction of the passages, their changes of direction, the friction of the steam, its waste and its condensation. Now of the last

* Treatise on Locomotive Engines, second edition.

five causes, the condensation is the only one that can diminish the *pressure* of the steam during its passage, and that condensation is almost entirely obviated by the precautions used in practice: all the remaining causes of reduction act merely on the velocity. If then these causes produce definitively a reduction in the theoretic effect, it can only be by reason of their action on the velocity.

But, to calculate, by this method, the theoretic effect of an engine, the area of the piston is multiplied first by the pressure of steam in the boiler, which gives the theoretic effort; then this result is multiplied, not by the *theoretic* velocity of the engine which is unknown, but by its *observed* or practical velocity. All reduction then applicable to the theoretic velocity is, by the proceeding itself, already made in the calculation, and cannot be introduced into it anew.

Consequently, if notwithstanding the use of the practical velocity in the calculation, it be still necessary to retrench $\frac{2}{3}$ or $\frac{3}{4}$ from the result obtained, that loss of $\frac{2}{3}$ of the total effect must be due wholly to the friction, which is evidently impossible.

It is clear, then, that these inexplicable differences between the theory and the facts, can arise only from an error in the theory itself; that the results obtained from it are to be considered at most but as approximations, and not as being proper to determine, in an exact and analytical manner, either the effects or the proportions of steam-engines.

Section III.—Formulæ proposed by divers authors to determine the velocity of the piston under a given load; and proofs of their inaccuracy.

We have said that, in the above theory, the velocity of the piston under a given load, had not been made the object of a special research. Some essays had, however, been made to estimate this, but in a different manner.

1st. Tredgold, in his *Treatise on Railways*, (p. 83,) proposes a formula, without, however, establishing it in any way on reasoning or on fact. This formula is as follows:

$$V = 240\sqrt{l\frac{P}{W}}.$$

V is the velocity of the piston in feet per minute; l the stroke of the piston; P the effective pressure of the steam in the boiler; and W the resistance of the load. This formula, he says, will give the velocity of the piston. But as no mention is made therein, either of the diameter of the cylinder, or of the quantity of steam furnished by the boiler per minute, it clearly cannot give the velocity required; for if it could, the velocity of an engine would be the same with a cylinder of 1 foot diameter as with a cylinder of 4 feet, though the latter expends 16 times as much steam as the former. The heating surface, or evaporation of the boiler, would be equally indifferent. An engine would not move faster with a boiler evaporating a cubic foot of water per minute, than with another that should evaporate but $\frac{1}{4}$ or $\frac{1}{10}$. Hence this formula is unfounded.

2d. Wood, in his *Treatise on Railways*, (2d edition, p. 351,) proposes, also without discussing it, the following formula:

$$V = 4\sqrt{l\frac{P}{W}}.*$$

V is the velocity of the piston in feet per minute, l the stroke of the pis-

* In the third edition of his work, which is just published, 1838, Mr. Wood abandons this formula to adopt ours, as also our theory in general, developed in the Treatise on Locomotive Engines, 1835.

ton, W the resistance of the load, and P the surplus of pressure in the boiler above what is necessary to ballance the resistance W. This formula, containing no term to represent either the diameter of the cylinder or the evaporating force of the boiler, is, like the preceding, demonstrated inexact *a priori*.

We know of no other attempt made to attain the solution of this problem, and these are altogether unsatisfactory.

Consequently, of the three fundamental problems which we have presented, two have received inaccurate solutions by means of coefficients, and the third remains unsolved.

Section IV.—View of the theory proposed.

We have so far demonstrated that there exists no analytical formula, nor any exact means for calculating the effects of steam-engines, and, consequently, for determining the proportions proper to be used in their construction, to obtain desired effects. A great number of engines are constructed and intended to fulfil required conditions; but the truth is, that, unless they have been designed after others already executed, their precise effects are not known till they are submitted to trial after construction, that is, when it is too late to apply a remedy. In a machine, the most powerful of all known, and which is tending to become almost universal, errors cannot be without importance. Not only such errors have been frequently prejudicial to vast manufacturing enterprises, and the occasion of difficulties between the builders and the purchasers of engines, but they have also compromised the lives of travellers; for when a steam-vessel has been found incapable of accomplishing its destined task, the only remedy to the evil that has occurred to the engineer, has been that of overloading, or even of making fast, the safety valve, and frightful explosions have often been the result. No doubt then can be entertained as to the usefulness of new researches on the subject.

After having exposed the state of science in what concerns the theory of the steam-engine, it remains to show on what principles is grounded the theory we are about to present.

We shall first explain this theory in all its simplicity, supposing the steam to preserve the same temperature throughout its action in the engine, limiting ourselves to rotative engines without expansion, and taking our basis on the consideration merely of the uniform motion which the engine necessarily attains after a very short lapse of time. A great number of theoretical and practical proofs will then corroborate the accuracy of our reasoning; and, finally, in the subsequent chapters, we shall resume the theory in all its generality, so as to render it applicable to all systems of steam-engines, taking into account the circumstances neglected in our first exposition.

It is well known that in every machine, the effort of the mover first being superior to the resistance, a slow motion is produced, which accelerates gradually till the machine attains a certain velocity which it does not surpass, the mover being incapable of sustaining a greater velocity with the mass it has to move; the machine having once attained this point, which requires but a very little time, the velocity continues the same, and the motion remains uniform during the rest of the work. It is but from this moment, viz., the commencement of uniform motion, that the effects of machines begin to be calculated, and the few minutes during which the velocity regulates itself, or the transitory effects from the velocity null to uniform velocity, are always neglected.

Now in every machine which has attained a uniform motion, the power is strictly in equilibrio with the resistance; for were it greater or less, there

would be acceleration or retardation of motion, which is not the case. In a steam-engine, the force applied by the mover is no other than the pressure of the steam *against the piston* or *in the cylinder*. This pressure then, in the cylinder, is strictly equal to the resistance opposed by the load against the piston.

Consequently, the steam in passing from the boiler into the cylinder changes its pressure, assuming that which represents the resistance to the piston. This principle, of itself explains all the theory of the steam-engine, and in a manner lays its play open.

It becomes, in fact, easy to render an account of what passes in a steam-engine set in motion. The steam confined in the boiler, at a certain degree of pressure, as soon as the regulator or distributing cock is open, rushes into the steam-pipes, and from thence into the cylinders. Arriving in the cylinder, whose area is much greater than that of the pipes, the steam dilates at first, losing proportionally a part of its elastic force; but as the piston is as yet immoveable, and as the steam continues to flow in rapidly, the balance of pressure is soon established between the two vessels; and the piston, urged by all the force of the steam, begins slowly to move. The fly-wheel of the engine, its entire machinery, and the resistance opposed to it, begin then to acquire a small velocity, which accelerates by insensible degrees; and, if at the end of the stroke of the piston, the coming vapor were suddenly withheld, the piston would not stop instantaneously on that account; it would itself be impelled for some time by the effect of the velocity previously communicated to the mass. The result of this is, that at the following stroke the steam finds the piston already slowly receeding, at the moment it impresses thereon a new quantity of motion; which again passes on to the fly-wheel, and to the total mass, where it continues to accumulate. Receiving thus, at every stroke, a new impulse, the piston accelerates its motion by degrees, and, at length, acquires all the velocity the motive power is capable of communicating to it.

During all this time the steam continues to be generated in the boiler with the same rapidity, and to flow into the cylinder; but as the piston acquires a quicker motion and developes a greater volume before the steam, the latter dilates, assuming a lower pressure, till at length, the piston having assumed all the velocity that the steam can impress upon it, with the load that it supports, the pressure of the steam in the cylinder becomes equal to the resistance of the piston, and the motion remains in a state of uniformity, as has been said above.

Thus, from what precedes, we have the pressure which the steam really exercises against the piston; so that if P' represent that pressure per unit of surface, and if **R** represent the resistance of the load against the piston, divided in like manner per unit of surface, the condition of the uniformity of motion will furnish the first equation of analogy $P' = R$.

This equation establishes the intensity of the effort exerted by the power. Were the case merely one of equilibrium, this determination would suffice; but in a case of motion, not only the intensity of the force is to be considered, but also the velocity with which it is applied. Now, in the case before us, it is evidently the velocity of production of steam in the boiler, which indicates the velocity with which the above force is renewed or applied. To this latter element then of calculation we must recur, in order to obtain a second relation among the data of the problem, comprising the velocity of the motion.

This relation will be furnished by the consideration, that there is necessarily an equality between the quantity of steam produced and the quantity expended, a proposition which is self-evident. If, then, we continue to ex-

press by S the volume of water evaporated in the boiler per unit of time, and effectively transmitted to the cylinder, and by m the ratio of the volume of the steam formed under the pressure P of the boiler, to the volume of water that has produced it, it is clear that mS will be the volume of steam formed per unit of time, and under the pressure P, in the boiler. This steam passes into the cylinder and there assumes the pressure P′; but if it be supposed that the steam in this movement preserves its temperature, which as to the engines under consideration, will make but little change in the results, the steam, in passing from the pressure P to the pressure P′, will increase its volume in the inverse ratio of the pressures. Thus, transmitted to the cylinder, the volume mS of steam, supplied at each unit of time by the boiler, will become

$$m\mathrm{S}\frac{\mathrm{P}}{\mathrm{P}'}.$$

On the other hand, v being the velocity of the piston and a the area of the cylinder, av will be the volume of steam expended by the cylinder per unit of time. Therefore, on account of the equality necessarily existing between the production and expenditure of steam, we shall have the relation

$$av = m\mathrm{S}\frac{\mathrm{P}}{\mathrm{P}'},$$

which is the second relation sought.

Consequently, by eliminating P′ from these two equations, we have as a definitive analytical relation among the various data of the problem,

$$v = \frac{m\mathrm{S}}{a}\cdot\frac{\mathrm{P}}{\mathrm{R}}.$$

This relation, which is very simple, suffices for the solution of all questions relative to the determining of the effects or the proportions of steam-engines. As we shall develope its terms hereafter, on taking it up in a more general manner, we will leave it for the present under this form, which will render the discussion of it more easy and more clear.

We have, then, the velocity which the piston of an engine will assume under a given resistance R. If, on the contrary, the velocity of the motion be supposed known, and it be required to calculate what resistance the engine may move at that velocity, it will suffice to solve the same equation with reference to R, and we shall have

$$\mathrm{R} = \frac{m\mathrm{SP}}{av}.$$

Finally, supposing the velocity and the load to be given, and that it be required to know the evaporation proper for the boiler, that the given load may be set in motion at the desired velocity, the value of S must be drawn from the same relation, and it will be

$$\mathrm{S} = \frac{av\mathrm{R}}{m\mathrm{P}}.$$

We limit our deductions here, because, as has been already observed, these three problems are the basis of all problems that can be proposed on steam engines, and that they are sufficient, moreover, to enable us to establish our theory and to compare it with the mode of calculation now in use. But on resuming the same questions with more detail in the following parts of the work, we shall give to the equations their full development, and treat of all the other accessory determinations which occur in problems relative to steam engines.

From what has been stated, it plainly appears that we ground all our theory on these two incontestable facts; 1st, that the engine having attained uniform motion, there is necessarily equilibrium between the power and

the resistance, that is, between the pressure of the steam *in the cylinder*, and the resistance against the piston; which furnishes the first relation $P' = R$. And 2dly, that there is also a necessary equality between the production of the steam and its expenditure, which furnishes the second relation

$$v = \frac{mS}{a} \cdot \frac{P}{P'}.$$

And these two equations suffice for the solution of all the problems.

(To be continued.)

NEW CASTLE AND WILMINGTON RAILROAD.

Edward Stavely, Esq., civil engineer, has made a report on the contemplated road between New Castle and Wilmington. The charter for the construction of this road was granted by our Legislature in January last, and the following gentlemen were appointed commissioners:—Thomas P. Cope, Henry Toland, and Matthew Newkirk, of the City of Philadelphia; James Price and Allan Thompson, of the City of Wilmington; and Thomas Stockton, James Booth and James Couper, Jr., of New Castle. The charter enacts that the stock shall be divided into 3000 shares of fifty dollars each.

"The main object," says Mr. Stavely, "for the construction of a railroad from New Castle to Wilmington, appeared in the first instance to be directed to New Castle as a port of refuge for vessels in the winter season."—"Many vessels during the inclmency of the last winter found perfect protection; and amongst them a number of the first class of ships." Mr. Stavely states that "between the 8th of January, and the 1st of April 1839, the following number of vessels took refuge in the harbor of New Castle, viz: 18 ships, 26 brigs, and 52 schooners, exclusive of a number of sloops and other small craft—the aggregate tonnage of which, on a moderate computation, will exceed 20,000 tons." It also affords "a shelter and defence from the immense masses of drift ice on the ebb tide, carried, as they uniformly are, to the opposite shore by the westerly and northwesterly winds which are prevalent in the winter season and being situated on a prominent point of land the ice under the influence of flood tide is necessarily swept to the main channel without effecting the harbor to any extent." These facts, Mr. Stavely considers sufficient evidence that New Castle is entitled to a preference over any other port as a landing place and a harbor, on the whole line of the Delaware river below Philadelphia.

New Castle being thus proven to be an excellent winter harbor, the next consideration is, the safe and speedy transportation of goods, thence to Philadelphia. This is to be accomplished by the erection of a railroad from New Castle to unite with that of the Philadelphia, Wilmington, and Baltimore company at Wilmington—the distance from New Castle to Wilmington being five miles.

Mr. Stavely has made two estimates of the cost of such a road, one amounting to $80,661; the other to $60,102 67:—the difference arising from the kinds of rails and wood upon which they may be laid; what is called the I pattern laid on white oak mud sills costing $31,040; and the flat bar rails on Carolina pine scantling costing 111,916.

From the amount of merchandize and the number of passengers that may be carried on this contemplated road, Mr. Stavely considers it as offering great advantage to those disposed to embark their money in the enterprise. We give an extract on this head from the report:—

"Admitting then, that the sum of $80,000 will be required to complete

the work, it remains to show how a revenue of ten per centum per annum can be raised to secure a revenue of six per centum to the stockholder for the investment of his capital, and an ample allowance to meet the annual expenses of repairs, agents, etc."

"On inquiry as to the amount of travel between New Castle and Wilmington, taking into consideration their respective vicinities and the city of Philadelphia, with the preference given to the convenience and expedition of a railroad conveyance, it is fair to assume an average of 70 to 80 passengers per day. Taking then, the mean of 75 or 25 cents each, an annual revenue on that item alone will be produced amounting to $5843 74
and as it is impossible to form a correct idea of the amount of transportation of merchandize, but which I am sanguine enough to think will be very great; I allow therefore merely a competency to produce sufficient revenue to substantiate my argument.
I therefore admit to the nominal sum of $1156,25

Making a nett total of $8,000 00

—*Wilmington [Del.] Journal.*

STATISTICS IN RELATION TO THE NORWICH AND WORCESTER RAILROAD.—Length of road 58¼ miles, average inclination per mile, 11 feet—maximum inclination per mile, 20 feet.

Distance from Boston via. Worcester to Norwich, 103 miles—distance from Norwich to New York, 125 miles. Time by railroad, steamboat train, from Boston to Norwich, 5 hours—by steamboat from Norwich to New York, 10 hours.

Cotton Mills between Norwich and Worcester, within five miles of the route 75; Woolen Mills 27.

Cotton Mills in New London and Windham counties, containing 106,229 spindles; in Worcester county, 74 Cotton Mills, containing 124,720 spindles, being in these counties 230,949 cotton spindles.

Value of cotton goods manufactured in Worcester county $1,991,024.

Sixty-six Woolen Mills in Worcester county, manufacturing 3,748,852 lbs. wool into cloth, of the value of $3,695,321.

452,310 pairs of Boots, and

2,357,431 pairs Shoes, of the value of $2,791,298.

147,248 Hides, of the value of $387,038.

129,710 Axes, $119,825.

Chairs and Cabinet Furniture, $321,100.

Straw Bonnets $118,971.

Palm Leaf Hats, $411,554.

Total value of articles manufactured in Worcester county more than 12,000,000.

The manufacturers in that county of cotton, wool, hides, paper, iron castings, scythes, axes, cutlery, chairs and cabinet furniture, combs, ploughs, tin ware, and tanneries, number 456.

Amount of sperm oil consumed in woolen mills, 61,329 gallons.

The statistics of towns in Connecticut cannot be accurately ascertained. —*Boston Daily Advertiser.*

KITE'S SAFETY BEAM.—On taking one of the passenger cars off the track of the Columbia railroad, a short time since, it was found that one of the axles was broken. The car had run in that condition four trips between Philadelphia and Harrisburg. It was one of Joseph S. Kite's safety beams and hence no injury resulted.